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HUMANISM IN THE STUDY OF NATURE.

IN a liberal education we must hereafter recognize a twofold division of our labor. On the one hand will be placed those studies which serve the purpose of humanizing the youth, i.e., of bringing him into a state of sympathy with his fellow-mortals; and, on the other, the studies which will serve to give the required measure of knowledge concerning the unhuman world,—the realm of physical and organic nature. The great profit of the present discussions concerning education has been found in the fact that it has brought this dual character of the work of education clearly into view.

What, however, has this lower world of facts to give, that can be of such value that the student is told to turn from the field of man for its study?

We will pass quickly by the commonest argument. Unhuman nature, say many, concerns us because we have to live in it: it is a great engine, whose power may grind our grists, or whose merciless wheels may crush out our lives. Master its movements, that you may have power at your command; keep your frail self from its dangers, that you may live long. This is the way that some look upon the outer world. It is a sensible view, but in itself it little concerns the problem of education. From this point of view, nature is for the economist, for the practical man.

But for the purposes of a general education, the realm of nature beyond human interests should be approached with the view, first, to get some sound general idea of the construction of this realm, and its relations to the life of man in the largest sense of that life; next, to secure some clear sense of the nature of scientific evidence; and, lastly, to gain an idea of the order and control which exists in the extra-human world.

Purely human education is deficient in perspectives: it finds man as man; it considers his relations to his fellows, and leaves him separated from the universe, alone amid a world of physical and organic life. But to secure a sound understanding of man's place in nature, we must give the student some general ideas as to the ways of that nature.

This end should be secured by studies which begin with the human body and its functions, and afterwards extend progressively farther and farther away. We have thus the help of the human interest which surrounds our own personal affairs, and extends, through immediate

sympathy, to the lower world of living things. The elements of human anatomy and physiology should be the first thread to guide the student to the world beyond man. This may profitably lead to the study, in outline, of organic life below man,—a study which should aim at a clear understanding of a few lower animals and a limited number of plants. After the student has some accurate knowledge of the bodily parts and functions of a cat, a bird, a frog, and a fish, his mind is prepared to receive a little general truth given in words concerning the vertebrated animals. In the same way, an insect, a lobster, and a worm will give the basis for understanding the articulate animals; a snail, a clam, and a squid will show him his way to an understanding of the molluscan affinities; and so on. In the plants, a seaweed, a fungus, a fern, and an ordinary flowering plant, will, if well known, serve to make real a great many important general facts which have to be presented in a didactic fashion. In this teaching, constant effort should be made to give the matter a human interest by referring to man's body and habits, or his physical relation to the lower world, for comparison or illustration.

The next step will necessarily take the student into the realm of geology, or earth-history. Here the world of our day should be shown with especial reference to its relations to human life and its development. It is easy so to knit the considerations of the existing conditions of the earth with the interests of man. Over the bridge of human sympathies we may easily find a way for the student into the wider realm of the world-life. Climate may be studied with reference to human history, or the geographical distribution of organic beings, including man; volcanoes and earthquakes, with reference to their effects on the life of our species: so nearly every department of the earth's history may be made to have a relation to the natural human interests which the child brings with it to the study of the outer world. I know that there are those who will object to the anthropocentric, the over-humanized view of nature which this form of teaching tends to inculcate; but to the mass of men this is a necessary way of looking at the world. The worst failures in teaching science have come from a neglect of the all-important fact that nature is to most minds only interesting because of its relations to man. It may be—but may a merciful Providence defend us from the evil—that in time many children will be born to whom crystals are as interesting as human lives, and a geological period as full of

charm as the best age of Greece. To the specialist the remotest problems of science, doubtless, come to have living interest, become a part of his life, in fact; but they are not so to the beginner.

After some sense of the present conditions of the earth's surface is gained, the youth may be shown the evidences of the earth's past. It is particularly desirable that this inquiry into the old conditions of the earth should be so made as to aid the student to conceive the antiquity of the earth's past. This conception of past time is the most difficult to form of any of the large understandings of nature, while at the same time it is the most enlarging idea that can be obtained from geology. It gives much that will re-act on the youth's understanding of human history. If on viewing the slow gain of man in his progress from age to age, the persistence of evil beneath the guise of changed manners, and the inevitable sinking into the pit which seems in time to overtake all peoples, there comes to the student that sense of helplessness which so often assails the most ardent believers in the future of humanity, the geologic past has consolation for him. There he sees that 'one eternal purpose runs' through all those ages, and that the very catastrophes which seem to bring temporary ruin are but the steps to new life. Even more valuable than this is the impression of amplitude of time, which the student needs to secure as the basis on which to rest all his understandings of nature. Measuring the progress of all events from the infinitesimally brief duration of human life, the student is prone to impatience with the slowness with which this march of the ages goes on. Give him a sense of the larger space of the earth's history, and we relieve the mind of this prejudice.

Beyond the realm of the earth, it is not worth while to try to do much. Astronomy has, however, some tolerably simple and most important lessons. Its greater truths are unfortunately only accessible through the way of rather difficult mathematics; but there are some conceptions which are to be obtained with little labor, and which should be won. The order of the solar system, and the relations of the several planetary bodies, should be within the compass of minds entirely unskilled in mathematics. The first of these relations to be studied should be that which is found in the revolution of the earth around the sun, and the concomitant effects derived from the increase and diminution of eccentricity of its orbit, the precession of the equinoxes, and the rotation of the apsides. With a small globe (or, as well,

an orange), with pins to represent the poles, and a thread for the equator, a lamp on a centre-table to represent the sun, and a little exercise of limbs and wits in conveying the sphere around the table in a way to imitate the phenomena in question, the student can gain a clear conception of a most important series of relations. The student should then proceed to the work of extending the same order of conceptions to the other bodies of the solar system.

As in geology the student finds a profit in the expansion which the conception of vast duration forces upon the mind, so in the study of astronomy enlargement may be gained by the conceptions of space which are brought home to him in the study of that science. Neither geologic time nor celestial space can really be conceived by the mind; still, the effort to grapple with such immensities, though seemingly futile, is yet profitable. Especially if it be often repeated, this effort bears fruit in a sense of power which is given by no other mental exercise. Many things may give breadth to the mind, but among these widening agents the conceptions of time and space deserve high rank. It would be in a certain way true to say that we might get a measure of the greatness of a mind by its power to conceive a wide field of temporal and spacial relations. May we say that these measures enter the soul, and give it something of their dimensions?

We turn now to the use which we may make of nature when we seek to give the mind a conception of the relations of cause and effect, and the nature of evidence. The best field for such study is to be found in the department of physics and chemistry. There we may in many cases so isolate the phenomena we are examining, that they are uninfluenced by other conditions than those which can be perceived and taken into account. Studies in this field should begin with the phenomena of masses, with the effects of gravity, of momentum, and other actions where the facts are in the realm of tolerably familiar experience. Such personal experiences should be multiplied until the mind becomes habituated to the actions which it is contemplating. From this firm ground, studies should be extended to the obscurer phenomena of physics, or such as are found in those parts of the subject where the causes are invisible, as in the great field of electrical action. There the mind can become accustomed to the consideration of causes which are not only invisible, but outside of the limits of ordinary experience.

After some training in this department, the

student should next make acquaintance with chemical action. Here the aim should be to show the complication of laws which control the relations of bodies, molecules, and atoms, which entirely elude the senses. Nowhere else can the student so well attain to a conception of the penetrating influence of natural law or the infinite variety of its results. No other department of study will do so much to take away the idea of grossness, of inorganization, which the untrained mind applies to the world of matter. It is not necessary that the student should make much progress in analytic chemistry: the simpler the phenomena chosen for the study, as long as they involve the perception of quantitative relations, the better for this task. The main point to be attained is the comprehension of the principles of atomic and molecular relations, and an understanding of the nature of evidence as to causation, which this science, as well as physics, so well affords. Although the field to be gone over in these departments is not wide, it should be patiently and repeatedly traversed, in order that the mental effect should be clearly and firmly borne in upon the student.

We now come to the third end which we should seek to attain in our use of natural science in the work of education. This is the conception of the order and continuity which prevails in nature. In the lower states of human culture, we find the savage and half-civilized peoples looking upon the physical world as a domain which is under the control of superhuman yet essentially human persons. All the order and much of the apparent disorder of the outer world are accounted for by the control and the contentions of these superhuman powers. The advance towards monotheism gradually did away with this crude but natural conception of law; and in its place has come a dull, inert sense of the mere power of the physical universe, which has no educative value whatever, and which is in truth false to the facts than the conception of nature held by the orthodox Greek of the Periclean age. In place of the old animism which humanized all parts of the universe by giving its control to powers which were akin in nature to, and in sympathy with, man, we have now a set of meaningless terms which cloak our want of understanding.

The first aim of education should be, if possible, to restore the old sense of close sympathetic relation to the outer world which was lost with the death of polytheism. To restore it on the line of our new and higher knowl-

edge of the universe, man must in some way find himself in the world of physical life. Our monotheistic religion cannot do this work, for it turns the mind towards the infinite alone: it almost necessarily neglects the phenomenal world. Even the theory of design failed to lead men to the study of nature. Religion, in the proper sense of the word, concerns the moral side of man too completely to aid us in this task: if man is to gain a better reconciliation with the physical world, he must secure it on other lines.

The only possible way in which a real sense of kinship with the outer world can be aroused is through the sympathies, first by the sense of beauty in nature, next through the kindred sense of order or continuity of action in the physical world.

There is an instinctive progress towards this reconciliation which is brought about by the growing love of the beautiful in nature. It is hard to prescribe a way in which it can be fostered: it is not easy to do this work in the case of any sympathies; but the teacher will readily see that it is the most precious of all the means by which man can find his way to a more loving relation with the outer world. When the teacher of natural science can create or deepen the sense of the beautiful and the ordered in nature, he has done his work as minister in this great need.

In close relation to this sense of beauty is the sense of order in physical and organic nature. The teacher should endeavor in all ways to give the pupil a sense of the absolute continuity of action in the world. This difficult conception is perhaps best obtained by presenting the evidence that man is, at least in his body, the product of a continuous life, which, from the earliest ages to the present day, has gone step by step upward. Let the student grasp what he can of this overwhelming truth; let him see how, through all the accidents of this perturbed world, the life which has led to himself — his life, in fact — has gone unflinching forward to its end. We thus give him a feeling of his kinship with nature, — a sense of a kindly filial relation to the earth which will widen and deepen all the ways of thought.

Thus, without going very far beyond the theory of a thoroughly humanized education, without demanding more than one-third the schooling-time between the ages of ten and twenty, it will be possible to give the youth all the training which is necessary to secure the best that scientific culture can afford.

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